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I certify (37 CFR 1.8) that this correspondence is being transmitted on November 17, 2006 by first class mail to the Patent and Trademark Office at the address listed to the left.

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Commissioner for Patents
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PRIORITY DOCUMENT

Sir:

Transmitted herewith is a certified copy of Australian Application No. PR7720, filed September 17, 2001, priority of which is hereby claimed under 35 U.S.C. §119.

Respectfully submitted,

Charles W. Fallow
Reg. No. 28,946

November 17, 2006

Australian Government

Patent Office
Canberra

I, SHERYL WERCHANOWSKI, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PR 7720 for a patent by CRAIG ANTHONY KENNY, GARY JOHN RUSHTON and GREGORY JOHN LITSTER as filed on 17 September 2001.

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WITNESS my hand this
Third day of November 2006

SHERYL WERCHANOWSKI
TEAM LEADER EXAMINATION
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AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title:

AIRCRAFT AVOIDANCE SYSTEM FOR PREVENTING ENTRY INTO AN EXCLUSION ZONE

The invention is described in the following statement:

AIRCRAFT AVOIDANCE SYSTEM FOR PREVENTING ENTRY INTO AN EXCLUSION ZONE

FIELD OF THE INVENTION

This invention relates to a system for preventing aircraft from entering a predetermined exclusion zone. The invention has particular but not exclusive application where the predetermined exclusion zone includes a multi-story building.

PRIOR ART

Most commercial and military aircraft are equipped with a collision avoidance system. In the early 1990s aircraft were equipped with a Traffic Alert and Collision Avoidance System (TCAS) which is an airborne radio system that locates and tracks the progress of aircraft equipped with beacon transponders. With this system, the relative positions of nearby aircraft were tracked by the TCAS computer from the receiving and processing of signals and displayed in the tracking aircraft's cockpit. Alternative collision avoidance systems (US 5872526) have been developed using information from an onboard global positioning system (GPS) receiver, broadcasting location information to other aircraft and receiving and displaying information from other aircraft.

While collision avoidance systems have been developed for aircraft – aircraft collisions, there appears to be no or little development of avoidance systems for aircraft – stationary object collisions. Currently pilots use radar or visual signals emitted from beacons to alert them to the presence of a mountain or

building. Where a pilot does not recognize or chooses to ignore the warning provided by the radar or signals from the beacon, the aircraft will crash into the mountain or building causing the loss of life.

OBJECT OF THE INVENTION

It is an object of the present invention to provide an aircraft avoidance system for preventing aircraft from entering an exclusion zone.

SUMMARY OF THE INVENTION

According to one aspect, the invention broadly resides in an avoidance system for preventing an aircraft from entering in a predetermined exclusion zone including

transmitter means for transmitting a signal to the aircraft, said signal includes transmitter means identification and exclusion zone information;

aircraft receiver means for receiving and processing said signal, said aircraft receiver means is operationally associated with a flight director system which is programmed to control and steer the aircraft away from the exclusion zone in accordance with said aircraft's flight profile.

Said aircraft's flight profile is defined as a dynamic description of the aircraft's capabilities based on calculations including (but not limited to) the type of aircraft, current load, current velocity of the aircraft and current operational status of the aircraft.

The predetermined exclusion zone may be a single zone defining a space where aircraft are not permitted and are prevented from entering. The exclusion

zone preferably includes 3 sub-zones including an outer warning zone where an audible warning is sounded in the cockpit of an aircraft passing through the zone, a middle warning zone where an audio and visual alarm is activated in the cockpit of a trespassing aircraft, and an inner no-go zone where an aircraft is prevented from entering.

On receiving and processing of the signal the avoidance system is preferably activated. From calculations of the aircraft's flight profile and proximity to the exclusion zone, the avoidance system will preferably determine at what position relative to the exclusion zone the aircraft's flight director system (that is autopilot) will be engaged to steer the aircraft on a calculated course away from entering the exclusion zone. The avoidance action is initiated at a time and distance that enables the aircraft to move away using normal operational procedures without entering the inner zone or exclusion space. The flight director system of each aircraft will take control of the aircraft at comparatively different times as the flight profile of each aircraft is different. Preferably the avoidance action includes moving the aircraft in an upward direction while providing the pilot with limited sideways maneuverability.

The exclusion zone maybe defined by a perimeter about the transmitter means set at a predetermined radial distance from the transmitter means. The signal is preferably powered beyond the perimeter so that avoidance action can be activated before the aircraft reaches the perimeter. Alternatively the exclusion zone may be defined spatially by at least four coordinates where each coordinate has a longitudinal, latitudinal and altitude parameter. With four coordinates any desired three dimensional shape can be defined. A spatially defined exclusion

zone can define a three dimensional shape about a building or a group of buildings. In this alternative embodiment the signal is preferably powered to extend beyond the outer zone so that the signal can be processed and the avoidance programs activated before the aircraft enters the outer zone.

The transmitter means is preferably a transmitting beacon capable of sending a complex signal containing two or more different datum. The beacon will preferably have one or more supervisory receivers located within the perimeter of the exclusion zone to detect whether transmitting beacon is transmitting the signal. More preferably there is at least one supervisory beacon on or adjacent the transmitting beacon. The supervisory receivers preferably transmit to the relevant authority the status of the transmission from the transmitting beacon.

The signal transmitted from the transmitting beacon is preferably encrypted and transmitted over one or more frequencies. In one preferred embodiment, the signal is transmitted in a direct sequence spread spectrum (DSSS) which divides the signal in parts and transmits the parts over a band of frequencies.

The aircraft receiver means includes a signal receiver and a processor with avoidance software for processing the signal and activating the avoidance programs. The processing of the signal also requires the current flight profile and current position of the aircraft. The current position of the aircraft may be determined by the onboard GPS. The processor preferably calculates the position when the flight director system is activated and what course the flight director system sets when it is activated.

The aircraft's transponder is preferably activated to transmit an alert signal when the avoidance programs are activated to alert the relevant authority of the

situation. The alert signal preferably includes the aircraft identification, beacon identification and exclusion zone information for the beacon.

Where there are two or more signals received by the aircraft receiver means, the signals are preferably processed concurrently and a single larger exclusion zone incorporating the two zones encoded by the signals is calculated.

When the signal transmitted from the transmitting beacon is not recognized or the full signal is not received because of jamming or some other form of tampering, the aircraft receiver means will preferably immediately engage the flight director system.

In order to avoid possible problems with landing at airports or any other desired location, the avoidance program will preferably include a protocol where the avoidance system is not operational. Preferably coordinates of airports or their runways are entered into the avoidance programs as zones where the avoidance system is not operational. This information is preferably installed as part of the avoidance programs with a facility to update, amend or add new zones. The checking of these coordinates may be part of the initializing of the avoidance system during the preparation for flight. In conjunction with input from the onboard GPS, the avoidance system is non-operational when the aircraft enters the programmed zones.

To address the possibility of disablement of the on-board receiver means during flight, the avoidance system may include a self checking means where a low power beacon signal is installed on the aircraft to enable periodic validation of the receiver means to accept the signals from the transmitting beacons. The self checking means determines whether the receiver means is capable of receiving

signals. In the event of a failure of the receiver means, the transponder will signal the relevant authority with advise as to the status of the receiver means.

The avoidance system may also provide for notification by a satellite based system to receive registered exclusion zone parameters passed directly to the flight director by another independent sub system. The use of a satellite-based system provides a back up when there is a receiver means failure on the aircraft. The relevant authorities will be notified of the aircraft's current flight path and then conduct a database search to identify any exclusion zones ahead in the flight path. The exclusion zone coordinates would then be sent via satellite to the aircraft's flight director via another independent on-board sub-system to allow activation of the avoidance system. The exclusion zone may already exist in a flight directors database and if so will be verified and or updated as necessary. Should the receiver status not be restored by the time the aircraft enters the exclusion zone then it may be placed into a holding pattern around the exclusion zone or directed away from the exclusion zone.

In another aspect the invention broadly resides in a method of preventing an aircraft from entering in a predetermined exclusion zone using the above mentioned avoidance system including

transmitting a signal from the transmitter means;

receiving and processing the signal by the aircraft receiver means;

activation of the avoidance system with the receiving and processing of the signal;

engagement of the flight director system at a calculated position in relation to the exclusion zone and in accordance with the flight profile or deactivation of the avoidance system when the signal is no longer received;

where the flight director system is engaged, the aircraft is steered away from the exclusion zone and the flight director system is disengaged at a calculated position and the avoidance system is deactivated when the signal is no longer received.

The signal is preferably constantly transmitted from a transmitting beacon. The operation of the transmitting beacon is preferably detected by one or more supervisory receivers as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention be more readily understood and put into practical effect, reference will now be made to the accompanying illustrations wherein:

Figure 1 is a diagrammatic representation of the exclusion zone of the preferred embodiment and the flight path of a trespassing aircraft;

Figure 2 is a representation of the exclusion zone about a building and buildings;

Figure 3 is a flow diagram of the activation of the avoidance system;

Figure 4 is a diagrammatic representation of an aircraft's supervisory function; and

Figure 5 is a flow-diagram of the activation of an aircraft's supervisory function.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to figure 1, there is shown an exclusion zone 10. The exclusion zone 10 is defined by four coordinates with each coordinate having a longitude, latitude and altitude parameter. The exclusion zone 10 defines a three dimensional space. A transmitting beacon 11 is located on top of building 12 and transmits constantly a signal in all directions. The signal includes the beacon's identification and the exclusion zone coordinates.

The broadcasting of the signal from the transmitting beacon 11 is detected by four supervisory receivers 13 positioned about the transmitting beacon 11 and defining a rectangular perimeter. In other embodiments the supervisory beacon may be located on the transmitting beacon. Other supervisory receivers may be remotely located. Where the supervisory beacon 13 detects that the signal is not transmitted constantly it will remotely activate a secondary transmitter on the transmitting beacon 11 and send a signal to the relevant authorities such as the Federal Aviation Authority (FAA) that the primary transmitter has failed.

The exclusion zone 10 defines a space about the building 12. This space may take any suitable three dimensional shape but preferably defines a dome type shape. The exclusion zone 10 is divided into three sectors with an outer warning zone 14, a middle warning zone 15, and a no-go zone 16. The signal transmitted from the transmitting beacon 11 is powered to extend beyond the outer warning zone 14.

When the aircraft flies in range, the receiver detects the signal. When an aircraft receives the signal, the signal is processed and the avoidance system is activated. The avoidance system determines at what coordinate position the

aircraft's flight director system is engaged and the course that the flight director system steers the aircraft based on calculations involving the aircraft's flight profile, which is a dynamic description of the current status of the aircraft and the position of the aircraft in relation to the exclusion zone 10.

On receiving the signal, the aircraft avoidance system will activate the aircraft's transponder to send an alert to the relevant authorities advising that the aircraft is approaching an exclusion zone 10. A transponder signal is sent irrespective of whether the transponder has been switched off in the cockpit. When the aircraft passes through the outer warning zone 14, the avoidance system sounds an audible alarm in the cockpit of the aircraft. A further signal is sent by the transponder. When the aircraft enters and passes through the middle warning zone 15, the avoidance system activates an audible and visual alarm in the cockpit of the trespassing aircraft. Again another signal is sent by the transponder alerting authorities to the position and situation of the aircraft. At a predetermined position before the aircraft reaches the no-go zone 15, the flight director system engages, takes control of the aircraft and steers the aircraft away from the no-go zone 15. When the flight director system engages will differ for the different types of aircraft. In the preferred embodiment the flight director system steers the aircraft upwards. The flight director system steers the aircraft to increase its altitude and prevents the aircraft's altitude from being decreased until it is disengaged. The engagement of the flight director system is such that the pilot has limited control in maneuvering the aircraft left and right. This limited maneuverability is designed to avoid collisions with other aircraft. The flight director system disengages when the aircraft reaches a predetermined position

away from the exclusion zone 10. The avoidance system is deactivated when the signal is no longer received.

Where the signal is not recognized or is incomplete the avoidance system immediately engages the flight director system to steer the aircraft away from the exclusion zone 10.

As a security measure, the signal transmitted from the transmitting beacon 11 is encrypted in a secured format. The signal is also sent using direct sequence spread spectrum (DSSS) where portions of the signal are broadcasted over a band of frequencies. The use of DSSS is designed to minimize the effects of attempts to jam the signal.

To avoid possible problems in landing the aircraft, the avoidance system encodes protocols where the avoidance system is not operational in specified zones. The preferred embodiment of the avoidance system encodes the coordinates of airports, or their runways including specified landing corridors as zones where the avoidance system is non-operational.

To address the possibility of disablement of the on-board receiver means during flight, the avoidance system may include a self checking means where a low power beacon signal is installed on the aircraft to enable periodic validation of the receiver means to accept the signals from the transmitting beacons. The self checking means determines whether the receiver means is capable of receiving signals. In the event of a failure of the receiver means, the transponder will signal the relevant authority with advise as to the status of the receiver means.

The avoidance system may also encompass notification by a satellite based system to receive registered exclusion zone parameters passed directly to

the flight director by another independent sub system. If the receiver means is inoperative when the aircraft enters a registered exclusion zone the aircraft, will be placed in a holding pattern by the flight director system

The use of a satellite-based system provides a back up when there is a receiver failure on the aircraft. The relevant authorities will be notified of the aircraft's current flight path and then conduct a database search to identify any exclusion zones ahead in the flight path. The exclusion zone coordinates would then be sent via satellite to the aircraft's flight director via another independent on-board sub-system to allow activation of the avoidance system. The exclusion zone may already exist in a flight directors database and if so will be verified and or updated as necessary. Should the receiver status not be restored by the time the aircraft enters the exclusion zone then it may be placed into a holding pattern around the exclusion zone or directed away from the exclusion zone.

ADVANTAGES

The present invention provides the advantage that it forces aircraft away from buildings and the like irrespective of the intentions of the pilot. Furthermore it is an active avoidance system that implements a response appropriate for the type of aircraft.

VARIATIONS

It will of course be realised that while the foregoing has been given by way of illustrative example of this invention, all such and other modifications and

variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as is herein set forth.

Throughout the description and claims this specification the word "comprise" and variations of that word such as "comprises" and "comprising", are not intended to exclude other additives, components, integers or steps.

DATED THIS SEVENTEENTH DAY OF SEPTEMBER 2001

Craig Anthony KENNY,
Gary John RUSHTON,
and
Gregory John LITSTER

By their Patent Attorneys

Pipers Patent and Trade Mark Attorneys

Fig. 1

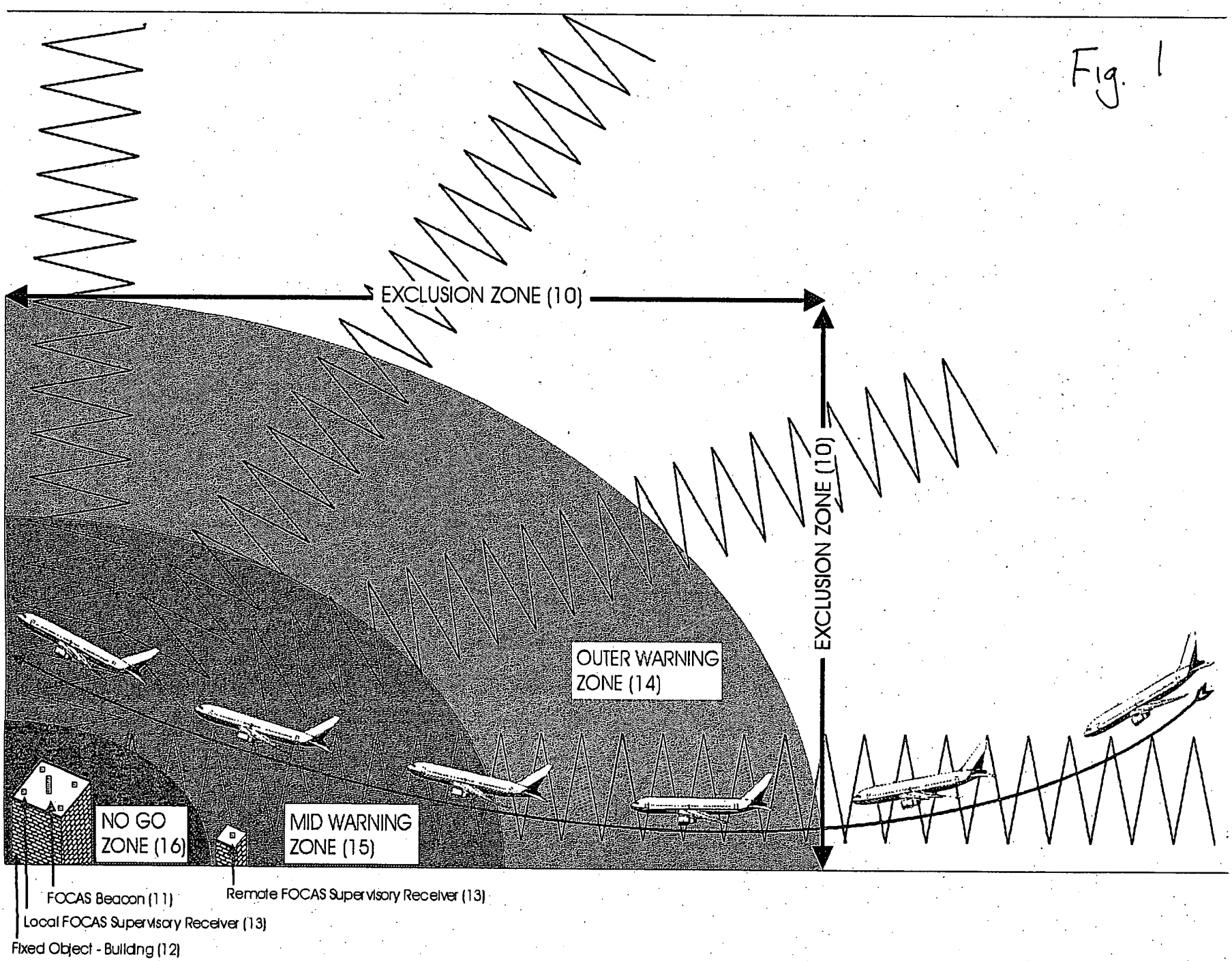

EXCLUSION ZONE (10)
EXCLUSION ZONE (10)
OUTER WARNING ZONE (14)
NO GO ZONE (16)
MID WARNING ZONE (15)
FOCAS Beacon (11)
Remote FOCAS Supervisory Receiver (13)
Local FOCAS Supervisory Receiver (13)
Fixed Object - Building (12)

Fig 2

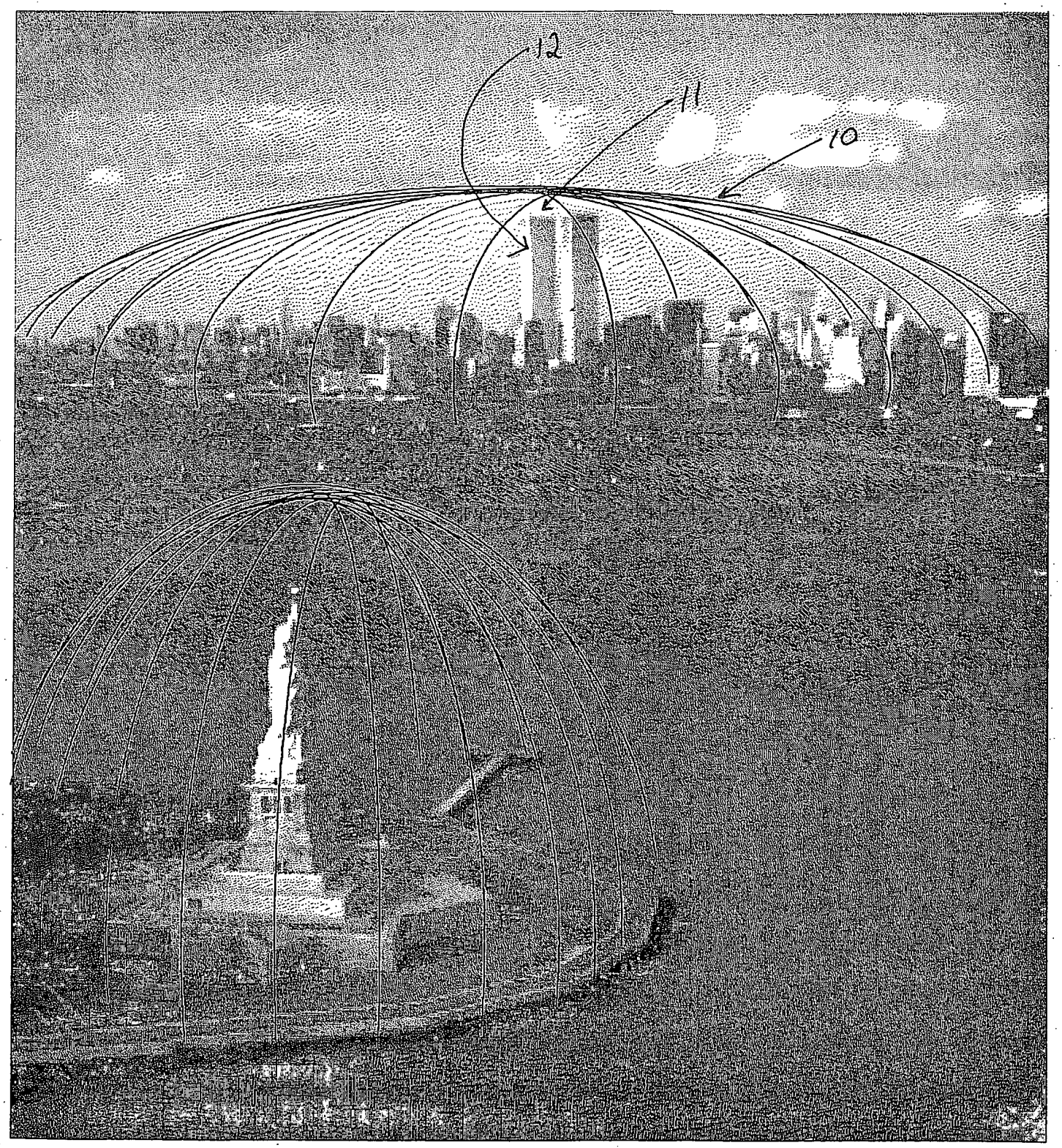


FIGURE 3

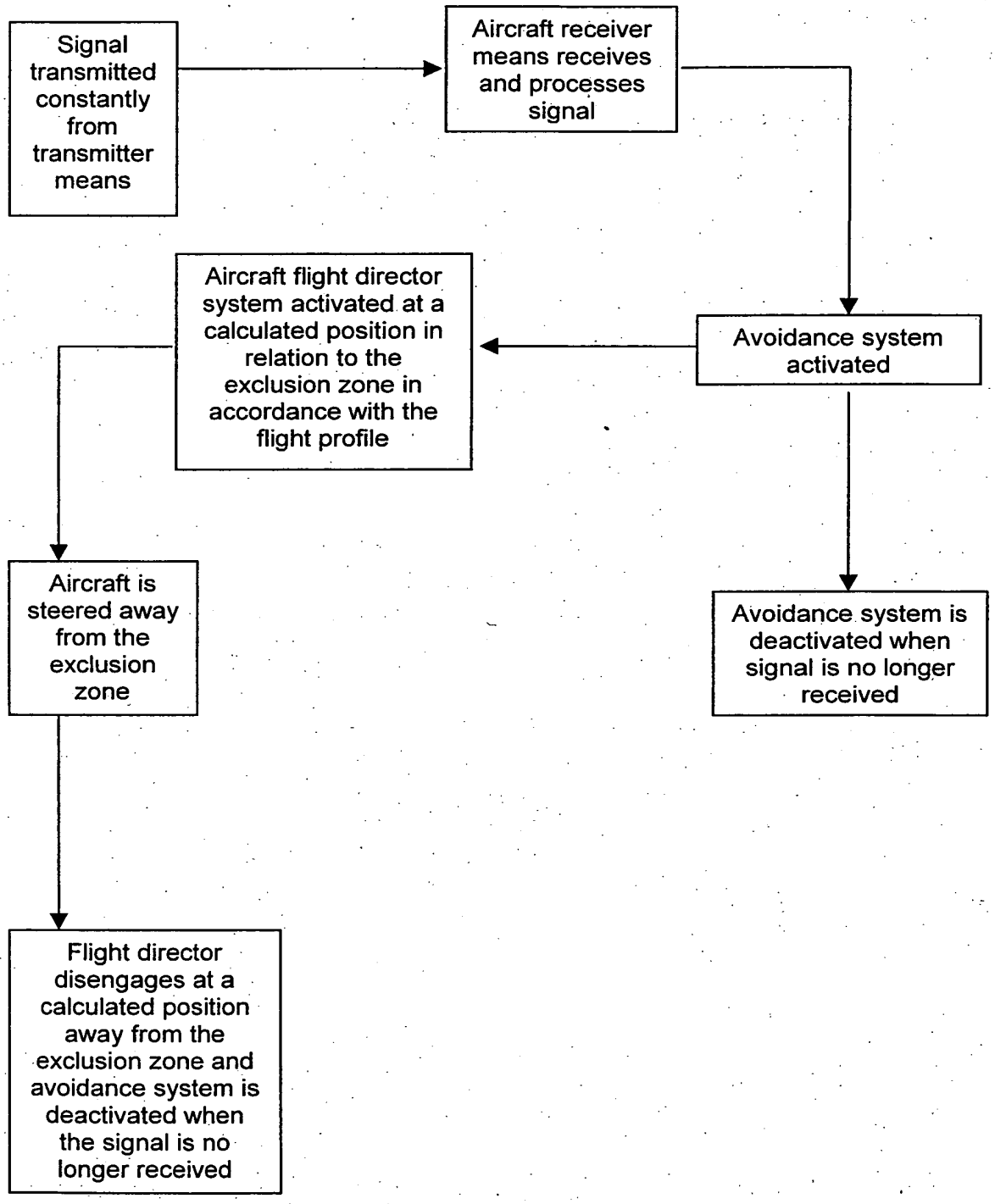

Signal transmitted constantly from transmitter means
Aircraft receiver means receives and processes signal
Avoidance system activated
Aircraft flight director system activated at a calculated position in relation to the exclusion zone in accordance with the flight profile
Aircraft is steered away from the exclusion zone
Avoidance system is deactivated when signal is no longer received
Flight director disengages at a calculated position away from the exclusion zone and avoidance system is deactivated when the signal is no longer received

Fig 4

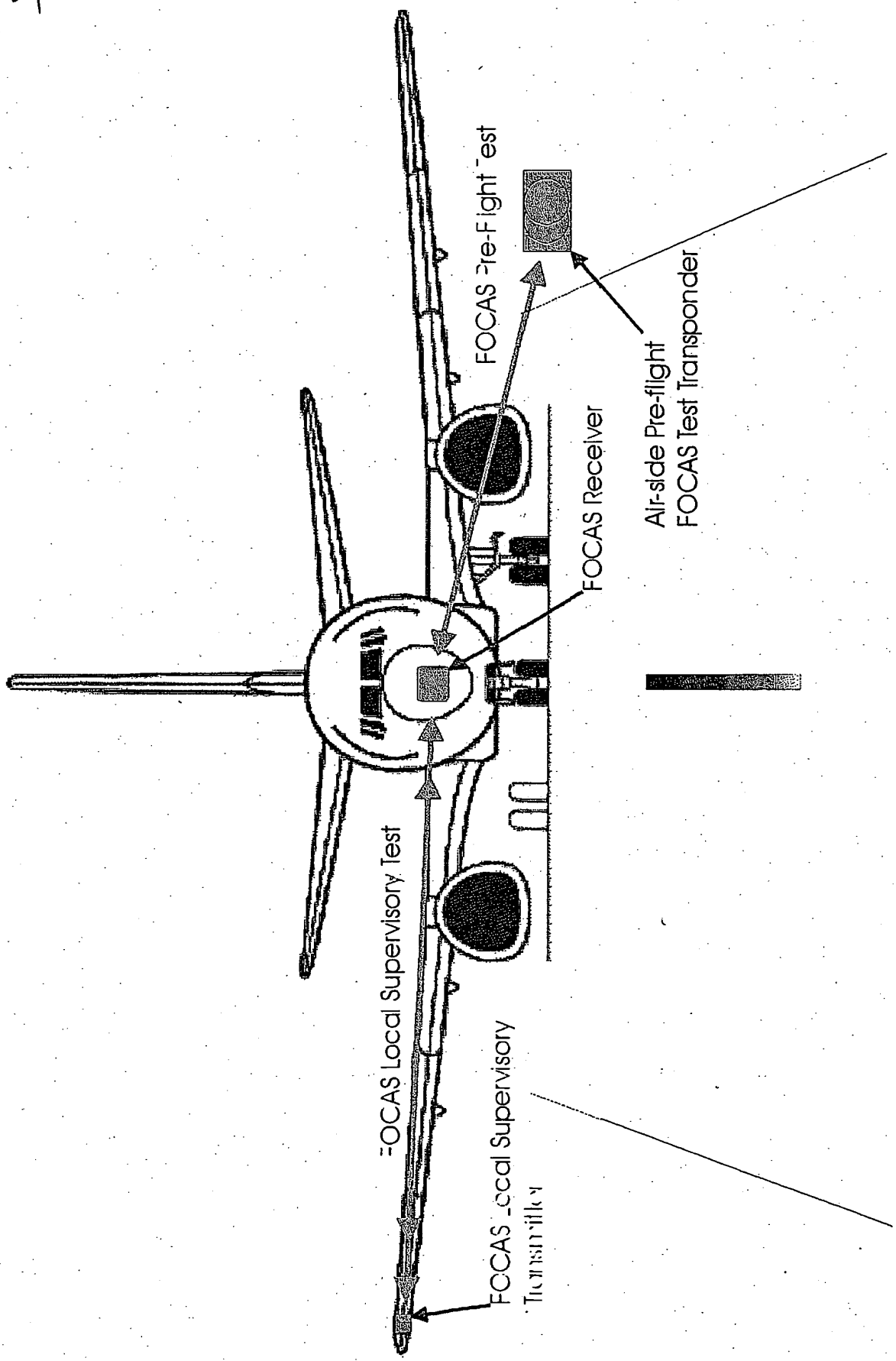
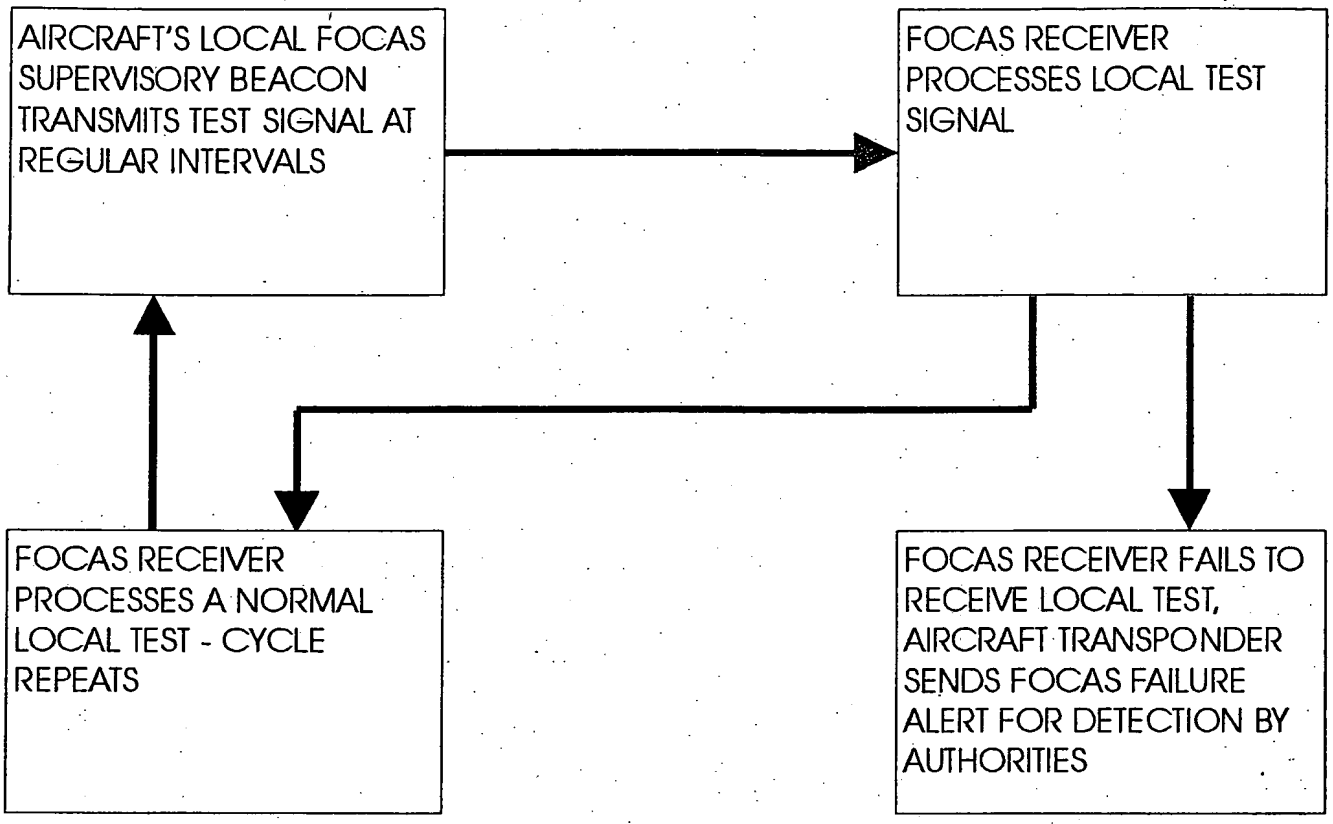

FOCAS Pre-Flight Test
Air-side Pre-flight
FOCAS Test Transponder
FOCAS Receiver
FOCAS Local Supervisory Test
FOCAS Local Supervisory

Fig 5

LOCAL IN-FLIGHT SYSTEMS TEST



PRE-FLIGHT SYSTEMS TEST